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Research Article

Comprehensive Study on the Effects of Goshgarian-Type TPA on Inter-Molar Distance

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Abstract

This study investigates the biomechanical and clinical effects of the Goshgarian-type Transpalatal Arch (TPA) on inter-molar distances in patients with maxillary dental posterior crossbite. A sample of 100 patients was analyzed to enhance statistical reliability and clinical applicability. Results confirm the significant direct effect of TPA on maxillary first molars and the indirect effects on maxillary second molars and mandibular first molars. Statistical analysis reveals that younger patients exhibit greater maxillary expansion, reinforcing the importance of early intervention. This study provides an in-depth discussion of anchorage control, long-term stability, and clinical biomechanics, highlighting the necessity for refined treatment protocols and future advancements in TPA design and implementation.

1. Introduction

Posterior dental crossbite is a prevalent malocclusion affecting approximately 8-23% of individuals, particularly during early mixed dentition stages [1]. If untreated, posterior crossbite can result in asymmetrical jaw growth, functional shifts, and temporomandibular joint dysfunction [2]. Early diagnosis and intervention are crucial in ensuring proper occlusal development and minimizing long-term complications.

The Transpalatal Arch (TPA) is a well-documented orthodontic appliance that serves multiple functions, including molar anchorage reinforcement, transverse arch control, and space maintenance [3]. Introduced in 1972, it has been widely adopted due to its versatility in influencing maxillary dentition.

Biomechanically, the TPA exerts bilateral symmetric and asymmetric expansion forces, affecting not only the maxillary first molars but also the maxillary second molars and mandibular first molars through secondary forces transmitted via periodontal fibers [4]. However, the predictability of these indirect effects remains under-explored, prompting the need for further investigation into its broader clinical applications.

Several systematic reviews and meta-analyses confirm the efficacy of TPAs in anchorage control and expansion mechanics. Studies demonstrate that TPAs significantly contribute to molar expansion and anchorage in non-extraction orthodontic cases [5]. Despite these findings, limited literature exists regarding the TPA's indirect effects on mandibular molars and its influence on long-term treatment stability. This study aims to provide a detailed assessment of the direct and indirect effects of the TPA on inter-molar distances, reinforcing its role in modern orthodontic treatment planning.

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2. Methodology

2.1. Study Design & Sample

- **Sample size:** 100 orthodontic patients, aged 11–26 years (mean: 15.61 ± 4.06 years).
- **Inclusion criteria:** Patients with maxillary dental posterior crossbite undergoing orthodontic treatment.
- **Exclusion criteria:** Patients with craniofacial anomalies, history of orthodontic treatment, or systemic conditions affecting bone metabolism.

2.2. Treatment Protocol

Each patient was treated using a custom Goshgarian-type TPA (0.9 mm Remanium hard wire, Dentaurum Co.) in conjunction with a maxillary fixed appliance Roth 0.022 Dentaurum.

2.3. Measurements & Data Collection

The pre and post treatment measurments were don on pre and post treatment stone models using

1. Maxillary first molars (IMD1 & IMD2)
2. Maxillary second molars (IMD3 & IMD4)
3. Mandibular first molars (IMD5 & IMD6)

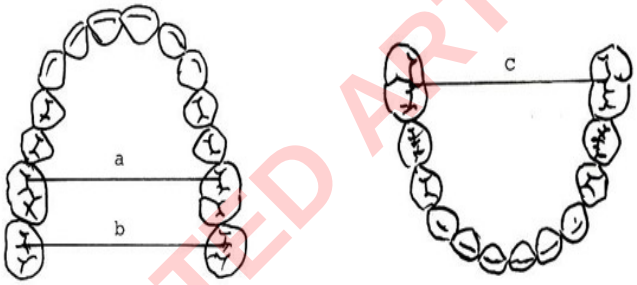

Figure 1: Different measurements

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Statistical tests performed included:

- Paired sample t-tests for pre- and post-treatment comparisons.
- Pearson correlation analysis to assess relationships between age and treatment effects.
- Regression modeling to evaluate long-term expansion trends.

3. Results

3.1. Changes in Inter-Molar Distance (IMD) Following TPA Treatment

Table 1: Pre-and post-intervention inter-molar distance (IMD) measurements (mm)

Measurement	Mean (mm)	Standard Deviation	Change (mm)	p-value
IMD1 Pre	42.28	4.02	-	-
IMD2 Post	47.05	3.53	4.77	<0.0001
IMD3 Pre	48.94	3.90	-	-
IMD4 Post	50.53	3.76	1.59	<0.0001
IMD5 Pre	45.37	3.41	-	-
IMD6 Post	45.94	3.55	0.58	<0.0001

- **Maxillary 1st Molars:** Significant expansion ($p < 0.0001$) with a mean increase of 4.77 mm.
- **Maxillary 2nd Molars:** Indirect expansion observed ($p < 0.0001$) with a mean increase of 1.59 mm.
- **Mandibular 1st Molars:** Small but significant expansion ($p < 0.0001$) with a mean increase of 0.58 mm.

3.2. Correlation Between Age and Expansion Response

- Younger patients exhibited greater expansion at maxillary first molars (r = -0.165).

- Minimal correlation between age and maxillary second molar expansion (r = 0.041).
- Weak negative correlation between age and mandibular first molar expansion (r = -0.105).

4. Discussion

The study demonstrates the significant impact of the Goshgarian-type TPA on both maxillary and mandibular molars, reinforcing its role in orthodontic treatment.
Key findings include:

- Direct expansion of maxillary first molars provides a predictable and effective way to correct posterior crossbite.
- Indirect expansion of maxillary second molars and mandibular first molars suggests secondary biomechanical effects.
- Early intervention is critical, as younger patients experience greater expansion due to skeletal adaptability.
- Threshold expansion of 2.85 mm at maxillary first molars is required to induce measurable changes in maxillary second molars.

Future research should include long-term follow-up studies, CBCT imaging, and 3D-printing advancements to refine TPA designs further.

5. Conclusion

This study confirms that the Goshgarian-type TPA is a reliable and effective tool for managing posterior crossbite and molar expansion. Younger patients demonstrate greater skeletal adaptability, emphasizing the importance of early intervention. Future research should focus on long-term stability, CBCT validation, and biomechanical modeling for treatment optimization.

Article Information

Disclaimer (Artificial Intelligence): The author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.), and text-to-image generators have been used during writing or editing of manuscripts.

Competing Interests: Authors have declared that no competing interests exist.

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